AMERICAN ELECTRO-PLATERS SOCIETY

(An Educational Society)

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Behold how good and how pleasant a thing it is for brethren to dwell together in unity.

MONTHLY REVIEW

American Electro-Platers' Society

(An Educational Society)

Vol. 2 DECEMBER No. 7

EDITORIALS

UNSOLVED PROBLEMS.

We are always reaching after the unknown, after having accomplished one thing it gives us inspiration to go forward. Ours, like all lines of science and industry, furnish opportunities. We must admit as electro-platers, that we are not up to others in seeking to know the causes and effects of conditions with which we come in contact with continually, but it is evident that we will not be in the rear all the time. With various conditions under which we labor such as different kinds and classes of work; the different facilities for doing same; the limitations of authority, and the practical and educational advantages of the man on the job, that which is easy for one may be a problem for another; but all electro-platers under every condition meet obstacles.

Our Society with members doing every kind of electro-plating and finishing furnishes the one common ground to meet on and exchange experiences, the reading of the Monthly Review also helps to solve somebody's problem and also results in bringing up new ones which still remain unsolved; no one man meets them all nor are they all alike, and some more serious than others.

Many will be overcome through the efforts of our own members, but we certainly appreciate the favor that comes to us from the American Electro-Chemical Society, seeking to be of service and requests through our Mr. Geo. B. Hogaboom that we make known to them the problems that seem to be beyond us at the present time.

With this spirit of co-operation, we owe it to Mr. Hogaboom, the American Electro-Chemical Society and ourselves to make the most of this request.

We will look forward to the time when so much of the now mysterious will vanish before the aggressiveness of our societies.

H. H. WILLIAMS.

CLEANING AND PLATING IN THE SAME SOLUTION.

By Dr. Oliver P. Watts, Wisconsin University.

Although the simultaneous cleaning and plating of metals in a single solution is now quite extensively practiced, the literature upon this subject is extremely scanty, being limited, so far as the speaker has observed, to a few patents and a brief article in one of the plating-trade periodicals.

In spite of the slight attention paid to this process in the books and periodicals devoted to plating, it is well worth a trial by every plater. After a series of experiments in the university laboratories, the speaker believes that the general adoption of the combined cleaning and plating solution will prove almost as revolutionary in plating-room practice as has the electric cleaner. Once adopted the plater will wonder how he ever did his work without it.

Before considering baths for cleaning and plating in a single operation it may be well to devote a few minutes to the electric cleaner.

It may be news to many here that electric cleaning of metals for plating by use of the dynamo current was discovered in Wisconsin at your own state university, but that such is the case is shown by a report in the Electrical World for October 29, 1898, of experiments by C. F. Burgess. Adoption of the process by platers proceeded very slowly, and it is only in recent years that the great value of this method of removing grease from metal has been generally recognized.

The principle of operation is simple. When an electric current is passed through a solution of any sodium or potassium salt hydrogen is liberated and a film of alkali is produced on the cathode. There is therefore a two-fold cleaning effect; the alkali tends to saponify animal and vegetable fats, and the hydrogen which is set free under the grease upon the metallic surface knocks off particles of grease in its escape. The higher the current density, the more rapid and effective the cleaning, because of the more violent evolution of hydrogen, and the greater concentration of the film of alkali produced by the current. If instead of using as electrolyte a neutral salt, such as sodium sulphate, or cyanide, which of itself has no action on grease, sodium carbonate, or lye can be substituted, the chemical action of these substances is added to the electrochemical cleaning already referred to, and the cleaning process is greatly accelerated. Lye also plays the part of a conducting salt, and greatly lessens the resistance of the solution. Heat is a great accelerator of electric cleaning. The tremendous effect of rise of temperature upon the velocity of chemical action is well-known, and the saponification of fats by alkalies is no exception to the general rule. Besides increasing the rate of cleaning by accelerating the action of the alkali present in the solution, heating greatly lessens the resistance and therefore increases the current. This

results in an enormous increase in the rate of cleaning by a hot, in comparison with a cold, electric cleaner. The use of cold electric cleaners is not to be encouraged, since ninety per cent or more of its possible cleaning power is not utilized at low temperature.

That the regular cyanide copper solution possesses some cleaning power has been known for many years. The reason is easily seen. When in use hydrogen is always evolved at the cathode and a corresponding amount of lye is produced there. This dissolving action of cyanide baths, under the influence of the current, on grease, combined with their solvent power for many metallic oxides, was probably the reason for the addition of cyanide to many of the earlier electric cleaners. Now that it is recognized that cyanide does not help the electric cleaner in removing grease from metals, its use has been generally discontinued.

To secure the greatest cleaning power from the electric cleaner requires a boiling solution strong in lye and, by the use of large electric conductors, the delivery of the full voltage of the dynamo at the cleaning tank. For cleaning metals which are attacked by lye, or where the maximum of cleaning power is not needed, soda ash or sal soda may be substituted for lye, and the bath may be operated below the boiling point.

In order that a plating bath may remove grease one of two things is necessary—there must be a vigorous evolution of gas on the work during plating, or the solution must be used hot and must contain enough lye or other saponifier of grease to clean by chemical action. Most effective cleaning requires a vigorous evolution of gas in a hot, strongly alkaline plating bath.

Many of the plating baths now in use evolve hydrogen vigorously only when strongly acid, or so weak in metal as to produce a burnt deposit. Many metals are precipitated by alkalies so that a strongly alkaline solution of them cannot be made. It is therefore evident that cleaning and plating in a single solution will be somewhat limited in its application.

Lovering's formula, previously referred to, for cleaning and depositing brass is as follows:

Lye	8 ounces.
Copper carbonate	2 ounces.
Zinz carbonate	2 ounces.
Ammonium carbonate	4 ounces.
Potassium cyanide	4 ounces.
Water	1 gallon.

For a copper solution he recommends the same without the zinc carbonate. Both solutions are used at the boiling point and are claimed to work with great rapidity.

Starting with Lovering's solution as a basis, many experiments have been tried in the university laboratories. It was soon found that the bath needed more cyanide than given in the formula, but even with a great increase of cyanide anode corrosion was not

satisfactory. The presence of lye caused a coating of copper oxide to form on the anodes. It was discovered that the addition of Rochelle salt dissolved this film and caused excellent anode corrosion, even at extremely high current densities.

The following is recommended as a good solution for cleaning and depositing copper:

English.		*Metric.*
8 oz.	Lye	60 g.
4 oz.	Copper carbonate	30 g.
8 oz.	Sodium cyanide	60 g.
12 oz.	Rochelle salt	90 g.
1 gal.	Water	1000 c. c.

The addition of 4 oz. of ammonium carbonte will cause a brighter deposit from a freshly made bath, but since ammonium salts are expelled by boiling lye, this addition is not recommended. Experiments with this and other solutions have already been described in a paper presented at the April meeting of the American Electrochemical Society, and therefore will not be repeated here. The solution should be used between 158° F. (70° C.) and the boiling point at current densities of 60 to 250 amperes per square foot.

The fraction of the total current devoted to cleaning may be controlled by regulating the amount of free cyanide. An increase of cyanide causes more vigorous cleaning, and increasing the current density has the same effect. Current efficiencies vary from 55 to 90 per cent, depending on the amount of free cyanide, the current density and the temperature. The less the current density and the higher the temperature, the greater will be the current efficiency. Lye is without effect on the current efficiency.

In comparing rapidity of deposition of copper from this and other solutions, it should be noted that a cyanide solution at 50 per cent efficiency deposits as much metal as the sulphate solution at 100 per cent. This fact, together with the low resistance due to the lye, and the very high current density which may be used without causing a burnt deposit, all combine to yield a more rapid deposition of metal than from any other bath in use today.

If a maximum of cleaning and a minimum of plating is desired, this can be obtained by diminishing the amount of copper and Rochelle salt, and increasing the amount of cyanide and lye. When it is desired to have a low current efficiency at the cathode, the composition of the solution should be altered in such a way as to keep the rate of solution of metal from the anode equal to deposition at the cathode, and thus maintain the original composition of the bath—which, in this case, means to diminish the amount of Rochelle salt—the material, which in the presence of free cyanide, promotes anode corrosion.

Experiments with this solution in plating sheets of copper, brass, zinc and iron, just as they came from the polishing wheels,

showed perfect adhesion of the deposit without the formation of a single blister. The remarkable power which this solution possesses of penetrating surface coatings of grease and rust, and depositing firmly adherent copper upon the metal beneath, is strikingly illustrated by the samples here presented.

No. 1. This is the raw material for plating—a bar of heavily rusted steel picked from a scrap pile where it had been exposed to the weather all winter.

Has any plater present a solution which he will guarantee to deposit a thick, firm, adherent coating of metal on this bar with no preliminary cleaning?

No. 2. Similar to No. 1, plated 5 minutes at 25 amperes, and scratchbrushed. The iron rust had been forced off from the part immersed in the bath.

No. 3. A bar similar to No. 2, from which a piece was cut with a hack-saw after plating to test the adhesion of the deposit, which proved entirely satisfactory.

Brass.

Experiments with Lovering's brass solution resulted in several changes in composition. One of the first solutions used had the following composition:

2 oz. zinc carbonate	15 grams.
4 oz. copper carbonate	30 grams.
8 oz. lye	60 grams.
7 oz. ammonium carbonate	50 grams.
10 oz. Rochelle salt	75 grams.
17 oz. potassium cyanide	120 grams.
1 gal. water	1000 c. c.

At 176° F. (80° C.) this solution deposited good yellow brass between current densities of 50 and 150 amperes per square foot.

This cleaning and plating solution is more difficult to control than the regular brass bath since the presence of lye is a disturbing factor. Lye, like cyanide, causes an increase in the proportion of zinc in the deposit, and since the presence of both of these substances is necessary for vigorous cleaning, this solution, unlike the regular brass bath, should contain much more copper than zinc.

The large amount of cyanide required by this bath in order to obtain a satisfactory color constitutes a serious objection to its use, and other combinations were tried. One of these, which gave an excellent deposit between 30 and 90 amperes per square foot consisted of:

4 oz. copper carbonate	30 grams.
1½ oz. zinc carbonate	12 grams.
8 oz. ammonium carbonate	60 grams.
7 oz. lye	50 grams.
13¼ oz. potassium cyanide	100 grams.
13¼ oz. Rochelle salt	100 grams.
1 gal. water	1000 c. c.

A half hour's operation at 176° F. and 62 amperes per square foot gave current efficiencies of 64 per cent at the cathode and 47 per cent at the anode, while a similar bath, except for the omission of the Rochelle salt, showed the same efficiency of deposition, but an anode corrosion of only 2½ per cent. In these brass solutions Rochelle salt has the same beneficial effect upon anode corrosions as was previously noted for the copper solution. Its use in a hot bath solves the troublesome problem of the corrosion of brass anodes. The remarks concerning ammonium salts in the copper solution apply here, and they should be left out of the solutions containing lye, which are to be operated continuously at or near the boiling point.

The solutions above mentioned are only two out of many possible combinations of copper carbonate, zinc carbonate, cyanide and lye, which will operate at high current densities and yield good brass deposits.

The best method for the plater to use to obtain a cleaning and plating solution for brass, suited to his particular needs, is to make up a cyanide copper solution containing lye, heat it to the temperature at which he intends to use it, and add zinc carbonate in very small quantities until the desired quality of brass is obtained. Increasing the quantity of lye in the original copper solution will lower the amount of cyanide and of zinc needed to yield a good yellow brass. Too little free cyanide will result in poor anode corrosion, even in the presence of Rochelle solt.

This procedure resulted in a good solution of the following composition:

2⅝ oz.	copper carbonate	20 grams.
8 oz.	lye	60 grams.
7 oz.	sodium cyanide	50 grams.
¼ oz.	zinc carbonate	2 grams.
1 gal.	water	1000 c. c.

At 176° F. and 36 to 56 amperes per square foot this solution gave an excellent deposit. Like the copper bath, it has remarkable cleaning power and in 8 minutes at 370 amperes per square foot produced a fine deposit through heavy rust.

For the facts concerning the brass solutions the speaker is indebted to Mr. R. E. Baker, scholar in chemical engineering during this year.

Nickel.

For a year past many experiments have been tried in the university laboratories in the hope of discovering a solution for cleaning and plating with nickel. At the outset this looked like an easy task, for it appeared only necessary to add lye to a hot solution of nickel sodium cyanide. On trial this solution cleaned effectively but deposited a mere color of nickel, too thin to be useful.

Glucose is one of several substances other than cyanide which prevent the precipitation of nickel solutions by alkalies. A hot

nickel solution containng glucose and lye proved to be an effective electric cleaner, and gave a nickel deposit of a fine color, but like that from the alkaline cyanide solution, it was too thin to be of service. A half hour's deposition at 52 amperes per square foot gave a current efficiency of only one tenth of one per cent. The substitution of sodium carbonate for the lye did not change the result.

Failure to succeed with alkaline solutions directed attention to acid baths, and some degree of success has been achieved with the following solution:

13 oz. nickel ammonium sulphate	100 grams.
2½ oz. sodium chloride	20 grams.
1½ oz. sodium citrate	10 grams.
¾ to 1 oz. citric acid	5 to 7 grams.
1 gal. water	1000 c. c.

Exact proportions are not necessary, the only need being enough acid to cause a violent evolution of hydrogen on the cathode. The bath must be boiling, and current densities of 40 to 250 amperes per square foot may be used. This solution has no solvent power for grease, and for cleaning depends entirely upon the mechanical action of hydrogen. Although its cleaning power is far less than that of the copper and brass solutions, it has been possible to give a sheet of brass twelve successive coats of nickel, each deposit being polished on a muslin buff with tripoli and immediately returned to the bath for the next coat. This solution may have some value for re-plating nickeled articles without stripping the original deposit. It is at present the only solution which the speaker can offer as a combined cleaner and plater for nickel.

As containers for the copper and brass solutions iron or steel tanks should be used, with an exhaust hood over each to carry off the poisonous spray thrown up by the escaping hydrogen. Ample current capacity should be provided in cables, tank rods, and sling wires. On account of the great evaporation from boiling solutions, it will probably prove most satisfactory to sacrifice something in rapidity of action by operating the baths just below the boiling point.

There is a very general opinion that combined cleaning and plating solutions are only suited to thin deposits. This is a natural, though mistaken view. The combined solutions for brass and copper can be made to deposit metal more rapidly than is possible in any of the regular plating baths, and are particularly suitable for heavy deposits. Blistering of deposits on iron, which is a common complaint of platers using the regular brass and copper solutions, has never occurred with the combined baths.

The only question as to their general adoption would seem to be in regard to the more rapid fouling of the solution by the dirt, which in the old method was removed in the cleaning tank and so kept out of the plating bath. Whether this will outweigh the

saving in time and labor made by the single bath is for the practical plater to decide. Should this fouling of the solutions prove a serious matter, the bulk of the dirt may be removed by a few seconds immersion in a hot electric cleaner, and the cleaning-and-plating bath may be regarded as only an extra rapid plating solution that is guaranteed to give a deposit which, like that oft-quoted smile, will not come off.

It may be well to take this occasion to call the attention of platers to the conditions under which most experimental work in plating must be performed in the laboratories of educational institutions.

In most cases research is not regularly provided for on the program, but must be done at such irregular hours of the day or night, as may be left over after all other demands upon one's time and energy have been met. Although an investigation may extend over many months before the final results are announced, the actual number of hours that the successful solution has been operated is rarely equivalent to a week's use under plating-room conditions. The college experimenter can rarely afford either the time or the material to give his supposed discovery the test of eight hours operation daily for a period of four to six months. It is not surprising then that laboratory processes often fail when put to the test of long-continued operation in the plating shop.

Yet it will never do for the plater to become discouraged, and cease trying the processes and methods announced from the laboratory. Progress is possible only through the substitution of better methods, processes and solutions for those now in use. The chaff must be sifted from the wheat, and the plater is the man who must do the sifting. Having done this it is his duty to report his results in the Monthly Review, or elsewhere in print, not only to call attention to valuable processes, but to save scores of others from wasting their time in trying that which has proved useless. A single report of failure should not, however, be regarded as final. There are those in whose hands nothing new ever succeeds.

O. P. W.

A DIRE PREDICTION.

By E. C. YAEGER, Milwaukee Branch.

The A. E. S. gives many things, you one time couldn't get,
Hold on to it for dear life, for it is your best bet;
It solves our plating problems, gives explanations true;
These with your own experience, will surely see you through,
Heed well this lesson, brother, don't let your payments lapse,
Lest you be suspended, by a better man perhaps.
March on with us to progress, if you at work would stick,
Or you may fall and have to wield, a shovel and a pick;
Get members, every plater can help us more or less,
So always try and get them in the A. E. S.

PLATING CONTRADICTIONS EXPLAINED.

By H. J. Ter Doest, Cleveland Branch.

Some platers seem to think that the other fellow is always wrong, and that many of the articles published on plating are contradictory. When the fact is that they often do not study the matter closely enough, as for instance:

A friend of mine asked me one day if I thought Hr. Hogaboom a good authority on silver plating, and what I thought about his article on getting carbonates out of cyanide solutions? I told him that that was the best I had ever read, as it gave a very practical method of doing something that I thought every one needed to know, and then he said, "What do you think of Mr. Mesle as an authority?" Again I said the same as Hogaboom.

Well, he says they contradict one another; one says take out the carbonates, and the other says put them in. I told him if he studied the articles a little he would find no place where Mr. Hogaboom said that he took all the carbonates out, but you will see where Mr. Mesle says that over 8 oz. per gal. is useless or hurtful.

Perhaps that much was still in Mr. Hogaboom's solution, as a study of the specific gravity would indicate.

Now, if someone had started a discussion, this would have no doubt been brought out, and a good many other things, about the difference in their contention of free cyanide, which looks reasonable to me, for if I am right, Mr. Hogaboom was at that time doing deposit work where it was easy to have anode as large as the cathode, while Mr. Mesle was doing either flat or hollow-ware and the chances are, that his anode was smaller than his cathode and consequently needed more free cyanide; it also shows that with a chemical analysis, a solution refuses to run to laboratory standards from day to day in different shops. And for the very good reason that every job has its own peculiarities and every plater works different.

Supposing for instance, we take for example a certain piece of work and a certain sized tank and put several men to do this work. We would probably see that each man was filling his tank with a different number of pieces, and using different voltage, and consequently needs a different solution; by that I mean a solution that has more load in his tank, or what is practically the same, more amperes of current going through. As it is well known that no two men have the same idea about what constitutes a load for a tank. The man with the speed mania thinks that by putting in two times as much work he can do it two times as fast because he can use two times as much current and get just as much plating on each piece in the same time. They will tell you that they can prove it, too, which by the way they can. But they do not know that by doing this, they are impoverishing the metal content of the solution and slowly but surely are not getting any more deposit than they used to get with half the current.

Unless they replenish their solution practically every day, a solution runs according as we use it, so if your metal is running out, you are using too much current for that particular solution, as a solution should keep up its metal from the anode, or perhaps you have not enough anodes, for a solution that is run properly will always be self-sustainng. By that, I mean the metal content will stay in the same relation to the density, and if such is the case we can readily see why a man has 3 or 4 different solutions in the same shop. One for each class of work, as he does not know how many square feet of surface he has, and simply puts in all the tank will hold and consequently the one that has the most work in proportion to anodes, runs itself out of metal more than the other one that has not quite so much surface. Now he thinks he has got that solution just right for that job, when as a matter of fact he is just drifting for, if he does any job in any tank for a while, he will soon find out that all his solutions are alike, and besides if one solution is such a wonder and money saver, why not put it in all around, for if it saves money one place it can also save money by having it in the other tanks.

The greatest cause of trouble to my mind is not having enough anodes to keep up the metal content of the solution, and having those few too long or longer than the work, which makes a nice combination to burn your work on the bottom. A solution poor in metal and long anodes, and furthermore it does not allow the proper current density to be used on account of the bottom of the work getting double the density that the top gets. It also dissolves your anodes near the top, breaks it in two, and is wasteful that way. Running a solution so it will keep up its own metal content from the anode will get out more work in the long run than forcing it will; although with proper attention to your solution, a little force may get out more work.

But it is only what you do and not what you should do that counts in getting the metal on your work, and the lines of least resistance are generally followed. As it is quite a job to keep a solution right that is being forced beyond its limits, consequently there is less work done on that account in the long run.

The reader also generally follows the lines of least resistance, and there is where they make a mistake instead of trying to study out just what the writer means.

An instance of this comes to my mind, when I first thought of analysis it occurred to me or I was told to use 37.8 c. c. or 1/100 part of a gallon, so as to make figuring easy. Afterwards when I read about the assay gallon, it was thrown aside, saying he is foolish, it can't be easier than 1/100 part of a gallon. Later I saw troy and avordupois assay gallon pipetts catalogued, and I hunted up the said article, and after a little study, it was decided that he was not quite so foolish after all, and so it goes with a lot of good articles.

I could speak all evening of foolish things I have done, but

am afraid they would not be interesting to you. I only mention this one to show how good articles are read and thrown aside instead of being studied a little to get the value of them.

There have been several good articles printed for wiring voltmeters to a number of tanks but you can go into a great many shops and see the multiple tank voltmeter in use, and not half the tanks connected right, because the multiple tank voltmeter is more complicated to wire up than the ordinary meter; but the supply houses have pushed it to the front and the plater does not want to study. We see articles about the various solutions and each one has a different formula for the same solution, simply because that particular man has in that particular place, found his solution in that condition when it worked best the way he was running it. Now he thinks he made that solution that way, when as a matter of fact, it just got that way from the way he was working it, as the amount of work in relation to anodes and the current density will always run a solution to that one point. But let him change his load or current density and his solution will also change and he will have another solution that is better for that particular kind of work, and he will think he made it that way also. Now if a plater was not afraid to study, he would come to the one conclusion that the same solution that does one class of work best, will also do the other work best if worked the same way. It will also do it the fastest.

Therefore standard solutions are what we want, and this standard should be a solution that will maintain itself best and deposit the most metal in a specified time with the same anode and cathode surface in several repeated trials on all kinds of work. As now we are simply drifting, and once in a while we get ambitious and make a test of our solution and proclaim it the best ever, without any knowledge of the possibilities. While we do not know that one solution will do all kinds of work, we also do not know that it cannot, for the very reason that we have been accustomed to drift instead of trying along well defined lines. I have very good reasons for believing that there are very few exceptions of articles that cannot be done in a standard solution, in fact the ability to do all kinds of work should be a large factor in its being adopted as a standard solution.

To show how we are now doing, you will notice that no two platers agree on the same solution, simply because they do their work in a different way and many have an idea that the more ingredients a solution has the better it is, when as a matter of fact we cannot keep a solution to a standard that has too many ingredients.

A typographical error in the November Review reinstated Col. Hansjosten as editor. Much is the Society would benefit by this we regret that such is not the case. We are still the editor.—

H. J. RICHARDS.

CYANIDE COPPER SOLUTION STRATIFICATION.

By W. S. Barrows, Toronto, Supreme President.

During the discussion of a question regarding the disintegration of copper anodes in a cyanide copper bath, at a recent session of Toronto branch, the following abstract from the transactions of the American Electro-Chemical Society was read and admitted to be a parallel illustration of the effects obtained in electro plating, with an excess of free cyanide in the copper bath:

"In the electrolytic refining of copper there are two attendant evils of special prominence. One is the tendency of the electrolyte to stratify or form layers of various compositions, and the other is the accumulation of impurities in the electrolyte.

"The stratification is caused by the formation of a heavy solution at the surface of the anode owing to the solution of copper, and by the formation of a lighter solution at the cathode owing to the plating out of copper. Unless the degree of stratification is greatly impeded, the result will be a very unsatisfactory cathode deposit, which will be at best heavy and lumpy at the bottom, while mealy and of poor quality at the top.

"The greater part of the current will pass through the strata of highest concentration, causing frequent short circuits and uneven dissolving action at the anode, with all the attendant deposition troubles."

The lines quoted have reference to acid copper solutions used in the electrolytic refining of copper. The subject under discussion by Toronto branch was "Why do copper anodes in a Cyanide copper bath wear away at the surface of the solution more rapidly than at the lower portions?"

It was stated that the solutions in which this action was most noticeable were made from carbonate of copper and sodium cyanide. No additions of carbonate of copper being made after the solutions were once in good working order; sodium cyanide only being added from time to time to produce a heavy pink copper plate, time of runs being from 10 to 30 minutes. Heavy electrolytic copper anodes are wore completely across their 12 inch width, at the solution surface line, while the lower portion retains its original shape, though wearing slowly, 12 inch anodes were seriously cut in this manner during one month's use. Anode surface in the bath always equal to, and frequently exceeding the cathode surface.

After a very interesting discussion, the concensus of opinion favored the stratified solution theory. The excess of cyanide at the surface of the solution causing the erosion of the copper anode at the solution surface line.

Agitating the solution was suggested as a remedy.

Discussion by the branches is requested.

REMOVING IRON SCALE BY PICKLING; THEORY VS. PRACTICE.

By Dr. Carl Hering, Philadelphia.

(Reprinted from Metallurgical and Chemical Engineering; permission obtained by Joseph Walters, Richmond, Va.)

When iron is worked into sheets, wires, tubes, etc., the well-known bluish-black scale is produced each time that it is heated to the annealing temperature, or in the case of tubes, to the welding temperature. This hard scale must be removed before the metal can be again rolled or drawn, or before it can be tinned or galvanized. This is usually done by immersing the oxidized metal in sulphuric acid, which is termed "pickling."

Many persons are contented with the knowledge of this fact that iron thus coated with scale can be cleaned by immersing it long enough in sulphuric acid; the method has been known and used for generations. Those manufacturers whose motto is to "let well enough alone," that is, those for whom the methods of their fathers and grandfathers are good enough, are satisfied with this process.

The progressive manufacturer, however, who believes in looking after leaks, will do well to study this process more carefully. This black oxide of iron is Fe_3O_4 and it will be found that this is not soluble in sulphuric acid, at least only with difficulty at objectionably high temperatures. In a test recently made by the writer, a piece of the scale alone, without any metallic iron, was immersed for a prolonged time in rather strong sulphuric acid (sp. gr. 1.2); no gases were evolved and it was found to have lost no weight. It may be that some varieties of Fe_3O_4 are soluble, but this hard, bluish-black kind produced in the annealing furnaces, does not seem to be. At rather high temperatures solution is claimed to take place, but such temperatures cause acid fumes to be generated which are very objectionable.

A possible reason for its not being soluble is the equation $Fe_3O_4+3H_2SO_4=3FeSO_4+3H_2O+O$ which shows that free oxygen would have to be evolved if it were soluble. As this oxygen was combined with the iron it presumably requires a supply of energy to free it. Moreover as this oxygen must be changed from its solid form in the oxide, to the gaseous form, still more energy is required to supply the latent "heat," or more correctly, the energy of volatilization.

As the oxide is already in a low state, from the energy standpoint, little if any energy can be expected to be set free by its solution. Hence it seems to be necessary to supply some energy from external sources. In the usual pickling process this is supplied by the dissolving of some of the metal itself, whereby good metal and acid must be consumed.

The action in the usual pickling process is therefore not a

direct solution of the oxide. The scale is removed partly by dissolving the iron underneath it, and partly by forcing it off by generating hydrogen gas between the scale and the surface of the clean metal by the dissolving of the metal by the acid. It is possible that some of the hydrogen evolved by the dissolving of the iron, combines with the oxygen which must be set free, and that an actual solution of the scale then takes place in part at least; if so, less external energy would have to be supplied.

But in any case, the action in the usual pickling process is dependent fundamentally on the dissolving of some of the good metal, and not on the dissolving of the scale alone. The dissolving of good metal is not an incident in the process, but is a necessary part of it.

The process is therefore intrinsically incorrect in principle, as it is not a true dissolving of the scale, but must consume good iron and a corresponding amount of acid. The scale is not dissolved (or only partly) but the good metal is.

In the electrolytic process, however, the action is reversed; the scale is rendered readily soluble and the metal insoluble, hence it is correct in principle, the scale alone being dissolved. In this process, first brought out by C. J. Reed, and patented by him, the iron is made the cathode, not the anode as was suggested before. In an experiment recently made by the writer, a sheet of this scale alone without any metal attached, was made the cathode in sulphuric acid, and it was found to go into solution very readily when a current was passed, thus showing that when made the cathode, this oxide dissolves readily. It is not reduced to metallic iron, but goes into solution as oxide.

The reason, apparently, is that the tendency to develop hydrogen at the cathode reduces this higher oxide to a lower one, which then is soluble chemically; or perhaps the higher oxide or the partially reduced oxide is dissolved electrochemically, as we know it is in the case of the peroxide of lead on the cathode in a nitrate of lead bath.

Another factor is that the energy which it seems must be supplied when this oxide is to be dissolved in sulphuric acid is now supplied by the current, and it is certainly much cheaper to generate this energy in a dynamo than by dissolving good metallic iron in sulphuric acid, as in the ordinary pickling process of our forefathers.

But whatever be the explanation, the facts are that this oxide is readily dissolved in sulphuric acid when made the cathode. It is also a fact that when the current density is high enough to keep the clean metal covered with hydrogen, no good metal will be dissolved. Hence it is correct in principle; it will dissolve the scale only, will not dissolve any good metal, and will require the consumption of only as much acid as is necessary to dissolve the scale.

Although the amount of good metal and acid consumed in the ordinary pickling process, and saved by the electrolytic process,

may be small relatively to the weight of the article pickled, yet when many tons of steel are cleaned per day, as in some large works, the value of these unnecessary wastes amounts to considerable. Mr. Reed (see Trans. American Electrochemical Society, Vol. VI, p. 182) estimates that this saving would be about 50 to 75 cents per ton, amounting in a single works to from $2,000 to $3,000 per day.

Another advantage lies in the fact that the oxide is sometimes formed in rather deep pits. To remove this by the ordinary pickling process would require a prolonged immersion, which would dissolve much good metal and probably make new pits, besides appreciably changing the thickness of the wires, sheets and tubes. The cost increases greatly when the oxide is in deep pits or adheres so tightly that it is difficult to dissolve the metal beneath it. While in the electrolytic process the oxide in such pits merely requires a longer treatment, but does not dissolve any metal, nor does it consume any acid uselessly.

In the case of tubes, the removal of the scale by the ordinary pickling process, sometimes involves the consumption of so much of the good metal that the tubes become seriously roughened and reduced in size and strength.

The anode in this process is most conveniently made of lead. The ordinary scale is removed in about a minute's treatment, less when thinner and more when thicker. The cost of the electric energy is very small, amounting to only a few cents per ton of wires and sheets. The iron comes out of the bath almost white, resembling silver, in marked contrast to the dirty gray appearance in the ordinary pickling process. It is then probably also in much better form for galvanizing and tinning.

In a recent test made by the writer under the ordinary conditions of pickling, that is, with dilute acid and at high temperatures (near the boiling point), the consumption of steel from sheets from which the oxide had been removed, was found to be about 1¼ lb. per thousand square feet per minute of immersion. It is, therefore, quite great, amounting to many tons per day in large works. Roughly, the acid required to dissolve this metal has about the same money value as the steel, or a little more, assuming the latter to be of good quality and to have had considerable work done on it. Both are unnecessarily wasted, as the above does not involve the acid usefully used to dissolve the scale.

Moreover, the surface of the steel which had been thus treated for about 50 per cent longer time than required for the pickling, was found under the magnifying glass to be full of fine pin holes and to be porous, hence would require far more tin or zinc to coat it, if, indeed, it could be well coated at all. A corresponding test made under electrolytic pickling conditions, while current was flowing, showed that no steel was disolved.

In another test made by the writer, one electrode was made of a slab of scale alone (without iron), the other of cleaned iron,

the solution being the hot, dilute one used for ordinary pickling. This was found to act as a battery of about 0.12 volt, the current in the liquid flowing from the iron to the scale, hence dissolving the iron. This shows that in the ordinary pickling operation, a local electrochemical action exists which dissolves the iron at the exposed parts.

A statement often made, especially by those who have little respect for scientific investigations, is that in specific cases practice has shown theory to be wrong. The present case is one in which it may be said that theory has shown the practice of many years to have been wrong.

The present war, so disastrous to Europe, has given a marked impetus to exports from this country, and if by reducing the cost of manufacture by such saving of waste and by other economies, the selling prices can be reduced, this country might be able to enjoy the markets of the world after the war. It is the well-known lack of attention to the saving of waste and to the smaller economies, which is an important factor in depriving us of the markets of the world in competition with other nations which give more attention to such details.

THE SONG OF THE SHIRT.

H. J. Richards.

With clothes acid eaten and worn,
With hands that needed some soap,
A plater sat at his desk one day
Looking over his dope.
Bossleur, Hawkins and Brandt,
Midst steam, polishers and dirt,
He looked until he was nearly blind,
But the thing he wanted he couldn't find,
So he sang while he changed his shirt.

Oh, woman with knives and with forks,
Oh, woman with stoves, he said;
It isn't the plating you're wearing out,
But gray matter out of my head.
Plate, plate, plate;
Midst steam, polishers and dirt,
He didn't know much, so he had to guess,
He didn't belong to the A. E. S.
So he cussed while he changed his shirt.

It's no use crying over spilt milk; half of it was water.

Because a man does not let his light shine is no evidence that he has any hid under a bushel.

THE COLORING OF METALS.

By W. D. Scott, Cleveland Branch.

In the coloring of brass articles such as chandeliers and lamp parts it is necessary to obtain almost any shade or tone.

As you know most finishes are known by various names, so that the finishes I speak of, I call them by the name we use for them.

The first shade or finish I will speak of is known as the yellow bronze finish. It is used mostly on floor and desk lamps. I obtain this shade after it has been buffed and prepared for plating in the usual way.

I stain the article in a solution composed of copper nitrate, copper acetate and a little sal ammonica. Run cold, but a pan of hot water is used for immersing from one to the other; then I sand the article to make it uniform; then it is left in the hot water until you get the desired shade; it is then dried out in sawdust and lacquered.

We have what is called the French bronze finish and is obtained in the following manner: First you run the piece of work through the potash and sulphuret solution till you have a dark brown tone; it is then brushed off on a fine Tampico brush with pumice, leaving the brown in the background. It is then run through the stain as described for yellow bronze. This makes a very nice finish.

Then there is the old English finish, which is a nut brown tone. This is obtained by immersing in the potash and sulphuret a few times. It is then sanded on the parts shown brown, the rest is relieved in the same manner as shaded brass; dried and lacquered with a B. B. lacquer.

Dull brass finish—after dipping in the acid dip it is run through in the same manner as old English until you get a dark smutty brown, when it is scratch brushed with pumice stone on a brass wire brush.

There is no use for me to deal with statuary bronze, as this is a finish that is familiar to you all.

There are other shades we could talk on, that are used mostly on our work and may not be as important to some of you as they are to others.

I would like to say of the old ivory finish, I think this is a very nice finish on fixtures that show a background, although we don't do much of this, it is sometimes called for.

This finish is obtained by the spraying process. After spraying on an even coat of dull white enamel, allow it to dry; then rub the article all over with burnt umber thinned down with turpentine, using a soft brush. Let stand for a few minutes, then relieve with a soft cloth to suit your own taste.

WHAT THE BRANCHES ARE DOING

NEW YORK.

Meets second and fourth Friday of each month at 258 Pearl Street, New York City, 8 p. m. Secretary, Wm. Fischer, 345 East 23rd Street, New York City.

The regular monthly meeting of this branch was held at their rooms Friday evening, November 26th, with a fair attendance. The meeting was conducted by our president, Mr. Reama, and our laboratory committee gave us some demonstrations in verde antique finishes and the analysis of the silver solution. This branch will hold its annual banquet at the Broadway Central Hotel on the evening of February 19th, 1916.

CHICAGO.

Meets fourth Saturday of each month, 8 p. m., Western Building, Randolph Street and Michigan Avenue. Secretary, H. E. Willmore, 5911 South Boulevard, Chicago, Ill.

The regular monthly meeting was held Nov. 27th with O. E. Servis presiding.

The date of the annual banquet, originally set for December 11th, has been postponed until January 15th, at which time it will take place at the Grand Pacific Hotel. A number of interesting papers have been promised for the occasion and it is predicted that the banquet will surpass all former events of this kind given by Chicago Branch.

After the routine business had been dispensed with, a lively discussion of the following questions was had:

"What causes zinc red in bronze and brass solutions, and what is the remedy?"

"What effect does acetic acid have on nickel solutions?"

"What effect does licorice root have on nickel solutions?"

PHILADELPHIA.

Meets first Friday of each month in the Harrison Laboratory Building, University of Pennsylvania, 34th and Spruce Streets. Secretary, Philip Uhl, 2432 North Twenty-ninth Street, Philadelphia.

The regular monthly meeting of Philadelphia Branch was held December 3rd with President Samuel Barr presiding and a good attendance of members. Dr. Lukens favored us with another lecture on nickel solutions which was given close attention. Communication from Supreme President Barrows was read requesting the preparation of paper to be read at the convention, 1916. Also letter from Past President Hogaboom on silver plating problems. On Saturday, December 4th, was held the fourth annual banquet of Philadelphia Branch at the Windsor Hotel. Seats were provided for about forty guests. After partaking of a sumptuous meal all present listened to the following program with great interest:

Introduction, Samuel Barr.

"What He Believes the Philadelphia Branch Should Do," Walter C. Gold.

"Electro-Chemistry," Dr. Lukens, Electro-Chemist.

"What the New York Branch Is Doing and Has Done," Mr. Haddon, ex-President N. Y. Branch.

"What the Plater Should Do," C. G. Backus.

"What the Society Has Done for the Plater," Wm. Schneider.

Letters of regret were read from ex-President G. H. Proctor and Geo. Hogaboom, also W. J. Smart of the Eureka Spray Co., who was represented by Mr. A. A. Landan.

Various other members of the Branch made short addresses on the value of the Society and what it has done for them.

To show our high esteem in which he is held and appreciation of the interest he takes in this Branch, Mr. Gold, on behalf of the Philadelphia Branch, presented Dr. Lukens with a fitted traveling case and gold safety razor. Dr. Lukens in accepting the gift expressed his pleasure working with the Society.

MILWAUKEE.

Meets first Friday of each month at West Side Bank Building, 3rd and Chestnut Street. Secretary, E. C. Yaeger, 962 9th Street, Milwaukee, Wis.

We have decided to change our meeting place to West Side Bank Building, at Third and Chestnut Street, and will hold our first meeting there on January 7, 1916. Our meetings are well attended and our members feel that we owe much to the Monthly Review, as it maintains the strength of our Society.

CINCINNATI.

Meets once each month at Dennison Hotel, Cincinnati, Ohio. Secretary, F. H. Nordmann, 720 Froom Ave., Cincinnati, Ohio.

DAYTON.

Meets first Wednesday of each month at the Y. M. C. A., Dayton, Ohio, Secretary, Alphonz Lamourcux, 500 East First Street, Dayton, Ohio.

TOLEDO.

Meets the last Tuesday of each month at Toledo University. Secretary, James E. Nagle, 209 Navarre Ave., Toledo, Ohio.

ROCHESTER.

Meets second and fourth Friday of each month at University of Rochester. Secretary, C. V. Haring, 603 Dewey Avenue, Rochester, N. Y.

BUFFALO.

Meets first Saturday of each month at the University of Buffalo, 8 p. m. Secretary, John G. Murphy, 71 Dingens St., Buffalo, N. Y.

TORONTO.

Meets fourth Tuesday of each month at Occident Hall, Bathurst and Queen Streets. Secretary, Ernest Coles, P. O. Box 5, Coleman P. O., Toronto, Ont.

The regular meeting was held on Thursday, November 25th, and proved to be quite up to "standard." President Salmon occupied the chair and a full attendance of regulars and the new members. Mr. W. Thompson, who has returned from the war, where he sustained injuries to the legs, being present, was given an enthusiastic welcome. The question regarding the admission of assistant foremen was discussed thoroughly and the opinion expressed that provided the ruling was lived up to the letter no harm could come to the Society, but on the contrary it would gain a number of good members. After the routine business was over, a splendid discussion was held on "Nickel Plating" (a small title but a large subject), in which all present took part.

INDIANAPOLIS.

Meets second Saturday of each month at Hotel Dennison. Secretary, Louis Mertz, 925 Chadwick Street, Indianapolis, Ind.

Indianapolis Branch of A. E. S. held its regular monthly meeting November 13, 1915, with President Aufderheid presiding. While the attendance was not what it should have been those present seemed to be very much pleased the way things are progressing. It was decided that all bills be allowed. Motion carried that we vote "No" on assistant platers clause adopted at Dayton convention. Indianapolis Branch desires information on lead plating-steel.

ST. LOUIS.

Meets fourth Saturday of each month at Public Library Assembly Rooms. Secretary, F. C. Rushton, 4405 Blair Avenue, St. Louis, Mo.

At the last meeting of our Branch the question of laboratory was laid aside and the consideration of our annual banquet taken up, and it was decided to depart from usual custom of inviting men only and invite the ladies and make the program appropriate. Messrs. Musick, Deubelbeis and Rushton were appointed as committee on arrangements.

A question asked by one of our members was: "Is there any objection to using a chloride as a conducting sale in plating store work with nickel; if so, what are the objections?" The general opinion prevailed that there was no objection to its use.

Mr. Richards gave a very interesting and instructive talk on the best, quickest and most economical way to pickle casting and also exhibited model of most efficient way of installing an electro-cleaning tank.

On Monday, December 13, the banquet committee met and decided to hold the banquet on January 22, 1916, at the American Annex with a reception from 6 to 7 p. m., banquet and entertainment 7 to 10 p. m., and dancing 10 to 12 p. m. There will be an exhibit of different finishes of work.

CLEVELAND.

Meets last Saturday of each month at Central Y. M. C. A.

Secretary, Charles Werft, 331 *Strathmore Avenue, Cleveland, Ohio.*

At our meetings each month we are having interesting papers read and are sending these to our Editor.

DETROIT.

Meets first Tuesday of each month at 26 *East Congress Street. Secretary, B. E. Miller,* 543 *Townsend Avenue, Detroit, Mich.*

NEWARK.

Meets first and third Friday of each month, 8 *p. m.,* 47 *Bank Street, Newark, N. J. Secretary, Geo. Rutler, Jr.,* 333 *S.* 19*th Street, Newark, N. J.*

BRIDGEPORT.

Meets third Friday of each month at the office of the Brass World, 260 *John Street, Bridgeport, Conn. Secretary, Nelson Barnard,* 858 *Howard Ave., Bridgeport, Conn.*

APPLICATIONS FOR MEMBERSHIP.

BRIDGEPORT BRANCH:

Mr. Geo. M. Krouse.....212 Newfield Ave., Bridgeport, Conn.

CLEVELAND BRANCH:

Mr. Thos. Kane.....1631 E. 22nd St., Cleveland, O.
Mr. Geo. H. Randall (associate).....1317 W. 6th St., Cleveland, O.

CHICAGO BRANCH:

Mr. Edward G. Pfister.....203 Evans Ave., Aurora, Ill.
Mr. John Brewer.....Box 343, Batesville, Ind.

ST. LOUIS BRANCH:

Mr. Joseph T. Humbracht.....3943 Sinton Ave., St. Louis, Mo.

TORONTO BRANCH:

Mr. Wm. Cox.....177 George St., Toronto, Ont.
Mr. George W. Bottrell.....22 Fifth Ave., Toronto, Ont.
Mr. James Vallier.....Toronto, Ont.

ELECTED TO MEMBERSHIP.

CHICAGO BRANCH:

Mr. C. A. Barnes.....217 W. Illinois St., Chicago, Ill.
Mr. J. C. Junea.....476 Fulton St., Aurora, Ill.

DETROIT BRANCH:

Mr. A. Philip Brockway.....318 Hendric Ave., Detroit, Mich.

NEWARK BRANCH:

Mr. Philip Brod.....939 Grand View Ave., Westfield, N. J.

TORONTO BRANCH:

Mr. Philip J. Copper.....241 Roxton Rd., Toronto, Ont.
Mr. W. H. Cresswell, Jr.....58 Symington Ave., Toronto, Ont.

CHANGE OF ADDRESS.

Mr. D. A. Metz.....5838 Hazel Ave., Philadelphia, Pa.
Mr. W. H. Osborn.....4208 Farlin Ave., St. Louis, Mo.

HIAWATHA UP TO DATE.

In those days came Hans the Chosen,
Saying to the tribe of platers,
Let us journey to the Daytons,
To the land of the Ohio,
To the place of rushing waters,
To the big Algonquin wigwam.
And the tribe of platers listened,
Listened to the words of wisdom.
And they journeyed to the Daytons,
Came from big and windy cities,
From the far north came the platers,
From the Mighty East they journeyed,
From the Woolly West they gathered
To the Council fires of Dayton,
To the great Ohio pow-wow.
Fraine, the pale-face chief of Dayton,
Barrows from far-off Toronto,
Williams from the great Missouri,
Hogaboom, the wise and mighty.
Many mighty chiefs were gathered
At the Council fires of Dayton.
There the pipe of peace was smoken,
Laws were made there at the Council,
Chiefs were chosen by the platers,
Chiefs to rule the tribe of platers,
Barrows, Fraine, Williams and Stratton,
Chiefs of Wisdom great and mighty,
Who shall lead us in our battles,
Battles with the ohms and ions,
Acids, Alkalis and coulombs,
With the medicines of plating.
Then up spoke Great Chief Hansjosten,
Saying to the tribe of platers:
Come, we now must choose a writer,
Choose a brave to keep the sayings,
Write the sayings of the platers.
So they chose Great Chief Hansjosten.
Hans the chosen then they called him,
Chose him for his mighty stature,
For his wisdom and his beauty.
Fraine, the pale-face chief of Dayton,
Led the platers through the wigwams,
Wondrous wigwams, great and mighty,
Through the Hills and Dales they wandered
And the Council fires of Dayton,
And the feast at the Algonquin,
Never shall they be forgotten,
By the platers tribe who journeyed
To the place of rushing waters,
To the land of the Ohio.

—HY. J. RICHARDS.

AMERICAN ELECTRO-PLATERS SOCIETY

(An Educational Society)

Chartered 1909

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